You Are the Scientist!

Middle School Food and Agricultural Literacy Curriculum

Precepts

G. Physical Growth

G1. Practice healthy eating habits

National Standards

PS.02.03.03.a. Collect soil and plant tissue samples for testing and interpret the test results.

NL-ENG.K-12.12 – Applying Language Skills

NS.5-8.3 – Life Sciences

Student Learning Objectives

As a result of this **unit** the students will…

Explain the importance of maintaining soil quality.

As a result of this **lesson** the students will…

Collect soil and tissue samples for testing and interpret the test results.

Time

Instruction time for this lesson: 60 minutes.

Resources

Burton, L. DeVere (2010). Agriscience fundamentals and applications. Clifton Park, NY: Delmar, Cengage Learning. — Hodson, Kent. Retrieved July 19, 2009. From Santa Monica College, Structure of Plants Web site. — http://homepage.smc.edu/hodson_kent/plant_growth/Angiosperms/ID/basics.htm — National FFA Organization. (2003). LifeKnowledge Precepts and Signs of Success. — Plaster, Edward J. (2009). Soil science & management. Clifton Park, NY: Delmar, Cengage Learning. — Team C0111040 (2001). pH Scale. Retrieved July 18, 2009. Trom Thinkquest site. — http://library.thinkquest.org/C0111040/Popups/pop_diaphscale.htm — The Crop Tech Sap Analysis Test. Retrieved July 19, 2009. From Crop Tech Web site. — http://www.croptech.com.au/lab/sap.html

Tools, Equipment, and Supplies

Spade or trowel
Bucket of soil
Pencil / pen and notebook – one per student
Writing surface
Transparencies and projector
Flip chart paper – 7 sheets
Note cards – one per pair of students
pH test strips - available from drugstores or pool supply
Collected soil samples from various locations: crop field, garden, student's yard, school lawn/land lab
Paper towels
Distilled water
Plastic cups
Tablespoon measuring spoons
Markers – several per student
Mature leaves – at least one for each group
Standard pliers - one per group
MS.NR.4.4.AS.A - flowchart with blanks – one per teacher
MS.NR.4.4.AS.B- testing steps, teacher reference
MS.NR.4.4.AS.C. Sample sap analysis – one per pair of students
MS.NR.4.4.TM.A - flowchart with answers – one per teacher
MS.NR.4.4.TM.B - pH scale drawing with ranges marked – one per teacher
MS.NR.4.4.TM.C.– one per teacher

Key Terms

The following terms are presented in this lesson and appear in ***bold italics:***

Soil test

Tissue testing

Summary of Content and Teaching Strategies

Content Outline

Objective 1. Collect soil and tissue samples for testing and interpret the test results.

I. ***Soil test***: using various tests to measure properties that affect how well soil will support plant growth.

A. Collection procedure

1. Collect sample from five to ten sites within area being tested.
2. Mix individual samples to get composite sample for area.

B. Test procedure

1. Combine tablespoon sample with distilled water.
2. Insert test paper into solution for one minute.
3. Remove strip from sample solution and rinse with distilled water.

C. Interpret results

1. Visual appraisal: match the color of the test strip to the standard color chart that came with the test paper.

2. Evaluative analysis: determine the pH of the soil sample according to the chart.
3. Interpretation: what the pH measure indicates (acidic, neutral, basic).

II. ***Tissue testing*:** a scientific test to analyze plant tissue to determine the level of nutrients in the plant itself. Can be used as a way to see if something is hindering nutrient uptake.

A. Collection procedure

1. Cut the oldest mature leaf from the plant.
2. Plant sap should be extracted from the midrib or petiole of the leaf using pliers.

B. Test procedure

1. Follow the procedures outlined in the plant tissue test kit instructions.

C. Interpret results

1. Visual appraisal of sap analysis graph showing elements present in plant tissue
2. Evaluative analysis of graph to determine levels of each element
3. Interpretation: according to the sap analysis, what elements are lacking in the plant.

This lesson consists of conducting two separate lab tests. Proper collection procedure is included and demonstrated but soil and plant material should be collected ahead of time by teacher due to time constraints. The soil should not be touched with the hands any more than is absolutely necessary. This lab/lesson is written to be completed in a small group situation of four students per group. More student buy-in could be generated if students were allowed to bring soil from home to conduct their pH test on; however, proper collection procedures would have to be covered with the students before they collected their samples.

Prior to class, tissue analysis note cards must be created by attaching a sap analysis (**MS.NR.4.4.AS.C**) on one side and writing a different element from the analysis on the other side of each card. These should be placed around the room. Also, seven pieces of chart paper with the titles Normal, Very High, High, Low, Deficient should be placed around the room.

Begin by passing out **MS.NR.4.4.AS.A** for students to use in note taking. As the teacher demonstrates the steps, the students will write the procedure in their flowchart handout. As the steps are demonstrated, the master transparency sheet will be completed.

In our previous lesson we discovered the major components of growing media and learned how the growing media supports plant growth. Today we will be continuing in our exploration of how soil quality affects plant growth by getting our hands dirty! Knowing what is in our soil allows us to be much more effective growers, and we have the important task to collect and test soil to determine how it will affect plants that will grow in the soil. Then we will squeeze a few plants and see what happens as we consider actual plant tissue test results. Let's remain curious so we can build on what we already know.

Interest Approach

In order to help the students realize that they can conduct simple scientific tests and interpret the results, use a simple thermometer as an example for collecting and interpreting data. Pose the following question:

What would you do if your friend felt ill and had a chill?

Wait for students to respond about checking for fever. If no one responds fever then you will guide them to that answer.

Is there a piece of equipment or a tool that you could use to help determine if you had a fever? What could you use?

Allow students to respond until you hear the response "thermometer."

What steps would you follow to understand the information that the thermometer is indicating?

Guide response to comparing the temperature indicated by the thermometer with the standard body temperature of an average of 98.6˚.

What you have just done is conduct a simple scientific test and determine what your results mean. Turn to your neighbor and say, "Who would-have thought!"

As you deliver the next line, do motions like putting a cap on your head and say to students as they do the same motions:

Great job! Now let's get our thinking caps on. Follow me as I place my cap on my head. Get ready to think and work like a scientist!

Have students complete the motion.

OK, I see those thinking caps are on and you are all ready, so let's get started. Today we will take on the role of scientists to collect soil and plant samples, run tests on those samples, and interpret the data we produce. Let's get on with our investigation.

Objective 1. Collect soil and tissue samples for testing and interpret the test results.

I. ***Soil test*: Using various tests to measure properties that affect how well soil will support plant growth.**

A. Collection procedure

1. Collect samples from five to ten sites within area being tested.

You must collect the soil samples prior to class. To get the most effective samples, follow these helpful hints. When analyzing an area of soil (front lawn, flower bed, garden, or field), take random samples from several (five to ten) different locations within the area and mix them together. Students need to understand that samples should be taken from the correct depth in order to reach the "root zone" of the plants being grown in the soil. This is two or three inches below the surface of the soil for lawns/grasses and six to eight inches below the surface for flower beds, gardens, farm crop land, or other areas which will be tilled. Select an appropriate tool for collecting the sample. A clean spade, trowel, spoon or knife can be used. Bring a bucket of soil to class for demonstration and the composite sample for the test.

A flowchart helps us to understand steps in a process. Today we will be soil scientists. First we must understand and follow the steps to collect a soil sample so that we can conduct ***soil tests*** in order to grow more productive crops, healthy turf on a ball field, or even more attractive flowers in a landscape! Take 30 seconds and share with a partner what you think a ***soil test*** is.

Allow students to consult with a partner and call on one or two volunteers to share their answers. Then display **MS.NR.4.4.AS.A** as a transparency and instruct the students to capture the definition for soil test on their activity sheet. As the activity continues, fill in the blanks with a marker as students answer.

A soil scientist must use the correct tools and follow a set procedure in order to collect useful samples.

Looking at the first block on our flowchart, what do you think must be removed before we start collecting our sample?

Pause and then allow volunteer responses.

That is correct! In order to collect our best sample we must remove all surface litter or organic matter, which is all the plant material that collects on the surface such as leaves, grass cuttings, twigs, etc! Please fill in your blank on the flow chart.

Fill in the blank on the overhead while students fill their chart.

This step on the chart also tells us to avoid something. What do you think we should avoid when taking samples?

Pause and then allow volunteer responses. Guide to the answer of areas that are either wet or have no plant growth on them because they are not representative of the entire area.

Yes! Avoid wet and bare spots.

Now, let's imagine that this bucket of soil is an area in a garden plot that we want to collect some soil from to test. In order to collect our sample we use a clean spade and trowel in the following manner.

Demonstrate by inserting the spade into the bucket removing a spade of soil. Take a one-inch strip from the center of the spade with a clean trowel or two tablespoons from the center of the spade with a clean tablespoon. Place the selected soil in a gallon seal top bag. Uncover the next step on the flowchart.

How much soil does it look like went into our bag?

Guide students to a one-inch strip which equals approximately two tablespoons.

Yes, two tablespoons. But what does the second blank in the box stand for?

Pause and then allow volunteers to answer. Guide students to understand that when taking soil samples for an area, five to ten samples should be taken in order to get a good composite sample for the entire area. They should put the word "each" in the blank on the flow chart.

2. Mix individual samples to get composite sample for area.

According to what we have already done, what do you think goes into the next two blanks?

Allow students to answer "soil" for the first blank and "mix" for the second. Students fill in their answers on their sheet. Write answers on transparency.

Great answers! You are thinking like soil scientists but we have more to do! Our sample is collected but now we have to prepare it for testing. Please look at your next step on the flowchart. When I say SHARE you have 27 seconds to discuss with your partner what you think goes in the blanks and why. What questions do you have? SHARE.

After time has passed, elicit responses from the students. Guide students to the answers of "dry" for the first blank and "heat" for the second blank.

You've got this! We must note that this step is done by individuals who are going to be shipping their soil to a lab for more specialized testing and that it will not be necessary for us to follow that step today because we will conducting our own test for pH on our soil sample.

Now let's consider the last two steps on our flowchart. When I say SHARE you have 27 seconds to discuss with your partner what should go in these last blanks and why. Questions? SHARE.

Again, after time has passed, elicit responses from the students. Students should conclude that "removed" goes in the next blank and "ready" goes in the last blank and fill in their answers.

B. Test procedure

1. Combine tablespoon sample with distilled water.

Fantastic! Our flowchart is finished so now let's get on with testing our soil! Today we are using pH strips as an easy way to get a general idea of soil acidity (acid) or alkalinity (base). Hold up a pH test strip. Observe that the pH scale goes from 1 (acid) to 14 (alkali) with 7.0 as neutral.

Project **MS.NR.4.4.TM.B**.

When soil is too acidic or too basic important soil nutrients like nitrogen, phosphorous, and potassium are not available to plants.

Other soil nutrients, especially metals, become more available and may reach levels toxic to plants. Most plants prefer neutral or slightly acidic soils in the pH range of pH 6.0 to 6.8. Most soil nutrients are more soluble (able to be dissolved) when the soil pH is about 6.5 – 7.0, and a suitable pH range for many soil organisms, such as earthworms and bacteria, is 6.0-8.0. Knowing the soil pH of your site will help you select plants that will flourish better in that area and also give you the information you need to adjust your soil for particular plants to grow effectively.

When I say DRAW, you will draw the pH scale in your notebook. Label the range that allows for most soil nutrients to be available in one color and label the range that is best for soil organisms with another color. When finished please sit quietly and await further directions. You have two minutes to complete this task. Hold up one finger if you have questions, two fingers if you understand, or three fingers if you could teach the directions to a classmate. DRAW.

Excellent drawings! Now we will conduct our pH test. Hold up a finger for each item as you name the items from the list below.

Divide the students into groups of four.

When I say GO, the tallest person in your group will have 30 seconds to come and get a plastic cup, a soil sample in a Ziploc bag, a spoon, an envelope and a container of distilled water and bring them back to their group. You will then wait for further instructions. What will they be picking up?

Allow students to repeat.

What questions do you have? Okay, GO!

Wait for students to return with supplies to each of their groups and settle before proceeding.

Good job! Now observe your sample. Do you see any foreign material that we should remove from the sample before we continue with our pH test? If so, remove it now.

Allow students to check the sample for foreign material.

Your sample is now ready to begin testing. When I say TEST, the shortest person in your group will open the envelope and read the test procedure to the group. TEST.

Allow sufficient reading time.

Excellent job reading! Everyone in the group turn to your reader and say thanks for sharing the instructions! Good. Now, when I say MILKSHAKE, you will have two minutes to complete the first two steps in the directions. When you have finished step two sit quietly and wait for further instructions. What steps are you completing?

Students respond.

One and two are correct! What questions do you have? MILKSHAKE.

Monitor the groups checking consistency of soil samples.

To do the soil pH test:

Step 1. Put about 1 tablespoon of soil in a clean container.

Step 2. Add distilled water and stir until the sample is as thick as a milkshake. Let stand for one minute and add water if needed.

Wow, did you ever think you would be making a mud milkshake in class? Please hold up one finger if your sample is the correct consistency. Excellent! Now to complete our pH test, when I say COLOR, your group will have three minutes to continue to complete steps 3-6. Be sure to leave the test paper in for a full minute. COLOR!

Monitor groups as they complete the following steps:

Step 3. Put a piece of test paper in the solution. Leave it in for one minute.

Step 4. Take the test strip out and rinse it with distilled water

Step 5. Match the color of the test strip to the standard color chart that came with the test paper.

Step 6. Record your test results in your notebook and one member of the group go to the board and write their group number and the pH of their sample on the board.

3. Remove strip from sample solution and rinse with distilled water.

Allow students to rinse strip over cup.

Great job preparing the strip. Now you will need to use your best observation skills to analyze the results.

In this next part of the activity, students will be matching the color of the strip to the color chart that came with the test paper. Monitor their analysis and check for correct interpretation.

C. Interpret results

1. Visual analysis: match the color of the test strip to the standard color chart that came with the test paper.

Your group will match the color of the test strip to the standard color chart.

2. Evaluative analysis: determine the pH of the soil sample according to the chart.

Make sure your group has a consensus as to your test strip color match with the color chart.

3. Interpretation: what the pH measure indicates (acidic, neutral, basic)

Every person should record the corresponding pH in their notebook and indicate if their soil sample had a pH that is acidic, basic, or neutral. When I say COLOR, one group member will come write the group's number and the pH of their sample on the board. What questions do you have? COLOR.

Awesome work! Now let's consider what your results tell us.

Guide students in a discussion about the results of their soil pH test results according to their results recorded on the board.

Most plants grow best when the pH range is slightly acid (5.8 – 7.0). If the soil is too acidic then farmers add lime (a base) to adjust the pH. A few plants (gardenias, azaleas, and blueberries) grow best at lower pH levels. If the soil has a high pH (too basic) then a fertilizer containing ammonium sulfate or sulfur-coated urea will bring the pH down.

The next activity allows students to experience extracting the sap from the leaves you collected prior to class. They can squeeze the sap from the leaves or use the pliers supplied. They will only be extracting the sap for the purpose of seeing it. All plant sap analysis tests must be done in a lab with specialized equipment. For the purpose of this lesson, a sample from a plant tissue test retrieved from the Internet will be used for the students to evaluate.

II. *Tissue testing:* nutrients in the plant itself, instead of nutrients in the soil, are tested. Can be used as a way to see if something is hindering nutrient uptake.

OK, let's pause for a moment. We've just learned how to conduct a test to determine the pH of a soil sample so that we can use that information to help us produce healthy plants.

These tests allow the scientist to determine the nutrient needs of the plant just like a doctor can perform tests on us to make sure we are getting the right nutrition to keep us healthy.

What other tests can a scientist do to determine if a plant has all of the nutrients it needs to be healthy?

Allow responses and then continue.

What are some tests a doctor could perform on you to determine if you needed to know the balance of certain nutrients in your body? Turn to your partner and take one minute to discuss.

Allow discussion time. Ask for volunteers to share their thoughts. Guide students to the doctor taking blood to test for deficiencies that can affect their health.

Thank you for sharing! Agricultural producers want to have healthy plants. Healthy plants allow the producer to get a good crop to be able to sell and also ensure that the plant will perform at its best. The first step that the producer/farmer will do is a soil test. The soil test will allow the farmer/producer to know exactly what nutrients to apply to the soil to grow the plant or crop effectively. The soil test also prevents the farmer from wasting money by applying too much fertilizer and cause environmental implications.

If the farmer does not put enough fertilizer on the soil then the plant will not grow or produce as well which means he/she loses money because the output was not what was supposed to be. We must also care for our bodies by eating a healthy diet that supplies all of the nutrients that we need so that we will be healthy, grow, and perform our best. But did you know that just as the doctor can test your blood, we can test plant tissue to get a general estimate of plant nutrient levels in order to diagnose nutrient deficiency problems in plants! By combining the results of plant tissue tests with soil tests, growers can get a complete picture of the plant's nutrient status.

Go back to your activity sheet and write in the definition for tissue test.

Read aloud and then write the definition on the transparency. Mature leaves, paper towels, and pliers should be supplied for each group at a central location.

A. Collection procedure

1. Cut the latest mature leaf from the plant.

When I say SAP, the person in your group who is closest to the door will come to the table and pick up a leaf and a pair of pliers. When they return to the table, the group will sit quietly and wait for further instructions. What questions do you have? SAP.

Excellent! You have picked up a leaf from a (name the plant). For our test to be accurate, the leaf should be a freshly cut, mature leaf collected during midday.

2. Plant sap should be extracted from the midrib or petiole of the leaf.

Display **MS.NR.4.4.TM.C**. Diagram or picture of leaf with midrib and petiole identified. Ensure that students understand what the midrib and petiole are.

When I say COLLECT, you will have 30 seconds to use the pliers to release some sap from the midrib and/or petiole of your leaf by squeezing the midrib or petiole between your fingers or in the pliers. Allow the sap to collect onto your paper towel. COLLECT!

You will only mention the next step so that student knows it is part of the plant tissue analysis process. This process is done in a professional lab and will not be done for this activity.

B. Test procedure

1. Follow the procedures outlined in the lab plant tissue test instructions.

The sap we squeezed from the plant is exactly what the scientist extracts to conduct the sap analysis. If we were sending our tissue for analysis to a lab, we would clean and dry the leaves before packing them loosely in a paper bag and put that bag in a container for shipment.

The sap analysis lets the producer know what elements are present in his plants in what amounts. The students will be evaluating an analysis run by a lab to become familiar with determining how to interpret results for this type of test used in agriculture. Students will be finding a note card with the name of an element on it.

They will have to determine the amount of that element in the plant tissue and proceed to the chart paper labeled with the amount of that element according to the graph. Cards should be distributed around the room and easy to find. Make sure you place the chart paper on a surface that can be written on and where there is room for several people to wait and not obstruct the view of the chart paper.

C. Interpret results

1. Visual appraisal of sap analysis graph showing elements present in plant tissue

Now fast-forward, the test has been run by the lab and you have received the results in the mail. When I say GO, partners look around the room and find a note card. Look on the note card and evaluate the plant tissue analysis information on the card. Then proceed to the location labeled with a piece of chart paper where your information best fits.

2. Evaluative analysis of graph to determine levels of each element

Add the name of the element you are from your note card to the chart paper and wait there. You have two minutes to complete this task. What questions do you have? GO.

In this step the students will use the sap analysis on their note cards to see if they agree with the categories each team has placed their element in. Start with the first element and proceed around the room checking each group's choice for accuracy. Go to each chart and allow the team to tell what element they had and why they chose to put it there. After each pair shares, ask for the class opinion by a show of thumbs. Guide to correct placement if needed.

3. Interpretation: According to the sap analysis, what elements are lacking in the plant?

Awesome. I see every pair has made their decision. We will go to each group and hear each pair's decision. If you agree with their classification show a thumbs up; if you disagree show a thumbs down.

Review/Summary

Excellent work, scientists! When I say MOVE, you will have 10 seconds to quietly move back to your seats. MOVE. Today we learned how to collect, conduct, and interpret soil and plant tissue tests to determine some of the nutrient needs of plants. You all did an awesome job conducting and interpreting these tests. This is an important step in understanding how soil affects our plants and their productivity. Give yourself and your fellow scientists a round of applause for completing this work today!

Application

Extended classroom activity:

Conduct more extensive soil or plant tissue tests with test kits available for purchase at Lowe's or online from Park Seed Company or Hummert.

FFA activity:

Take a field trip to a local university's soil testing lab to interview a soil scientist and tour the lab.

SAE activity:

Use the soil-testing procedures to run your own soil tests on home gardens, fruit/vegetable production plots (Fruit or Vegetable Production SAEs) or to analyze flowerbeds/yards (Home and Community Development or Landscape Management SAEs).

Evaluation

MS.NR.4.4.ASSESS.A

Answers to Evaluation

1. soil testing
2. tissue testing
3. Step 1. soil
   Step 2. distilled water
   Step 3. water
   Step 4. test paper
   Step 5. test paper
   Step 6. color
4. sap
5. optimum

Name _____

Directions: Fill in the blank to complete each statement.

1. **Using various tests to measure properties that affect how well soil will support plant growth is called _____ _____ _____.**

2. **When nutrients in the plant itself, instead of nutrients in the soil, are tested, this is called _____ _____.**

3. **To do the soil pH test:**

   Step 1. Put about 1 tablespoon of _____ in a clean plastic cup.

   Step 2. Add _____ _____ and stir until the sample is as thick as a milkshake.

   Step 3. Let it stand for one minute. Check it and add _____ if needed.

   Step 4. Put a piece of _____ _____ in the solution. Leave it in for one minute.

   Step 5. Take the _____ _____ out and rinse it with distilled water.

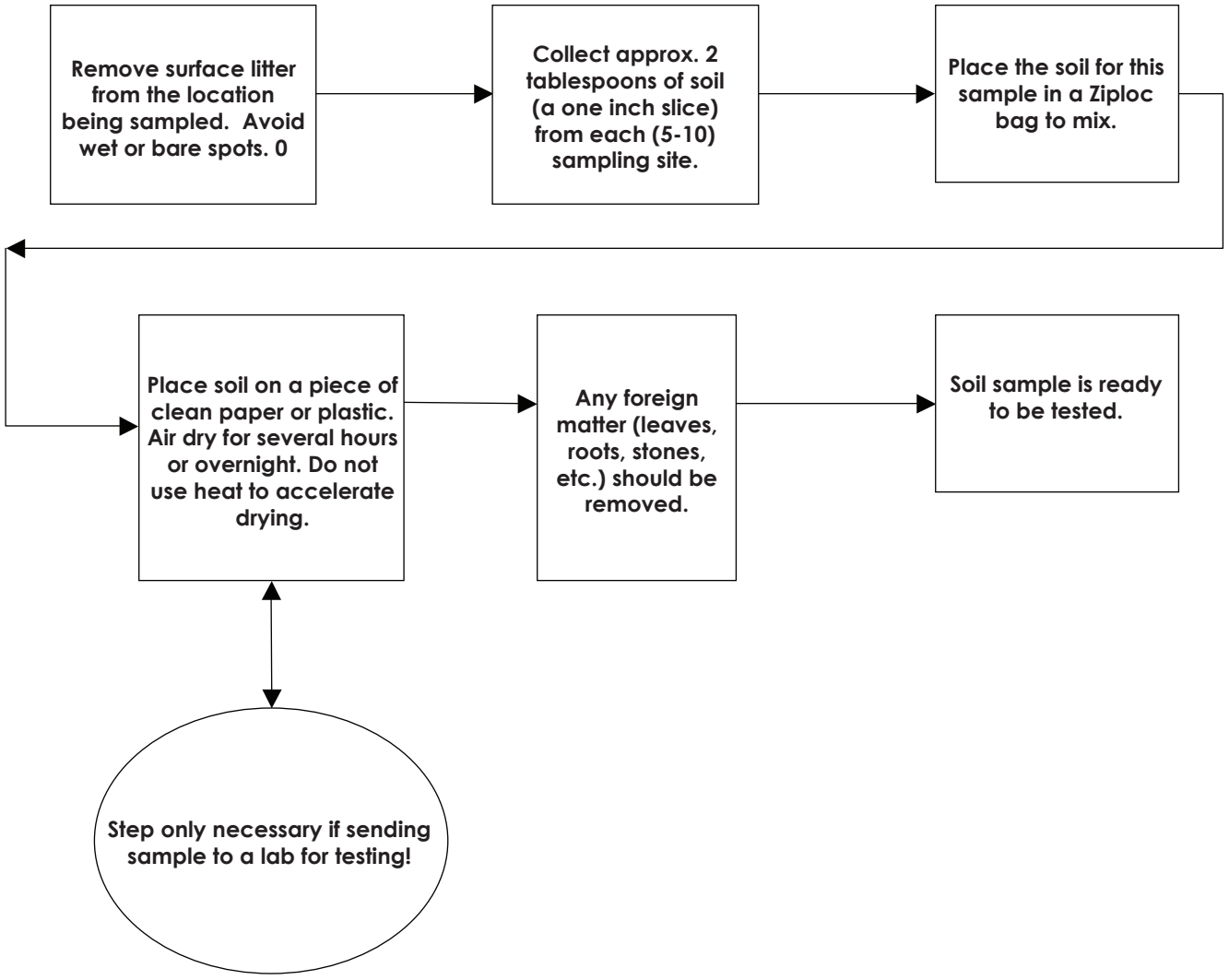
   Step 6. Match the _____ of the test strip to the standard color chart that came with the test paper.

4. **Your plant tissue test required you to extract the _____ from the midrib and petiole of a leaf.**

5. **Nutrients analysis on a tissue test results sheet categorize nutrients in the plant as very low, low, medium low, _____, medium high, high, and very high.**

Soil Collection Flow Chart

Soil Test: using various tests to measure properties that affect how well soil will support plant growth.

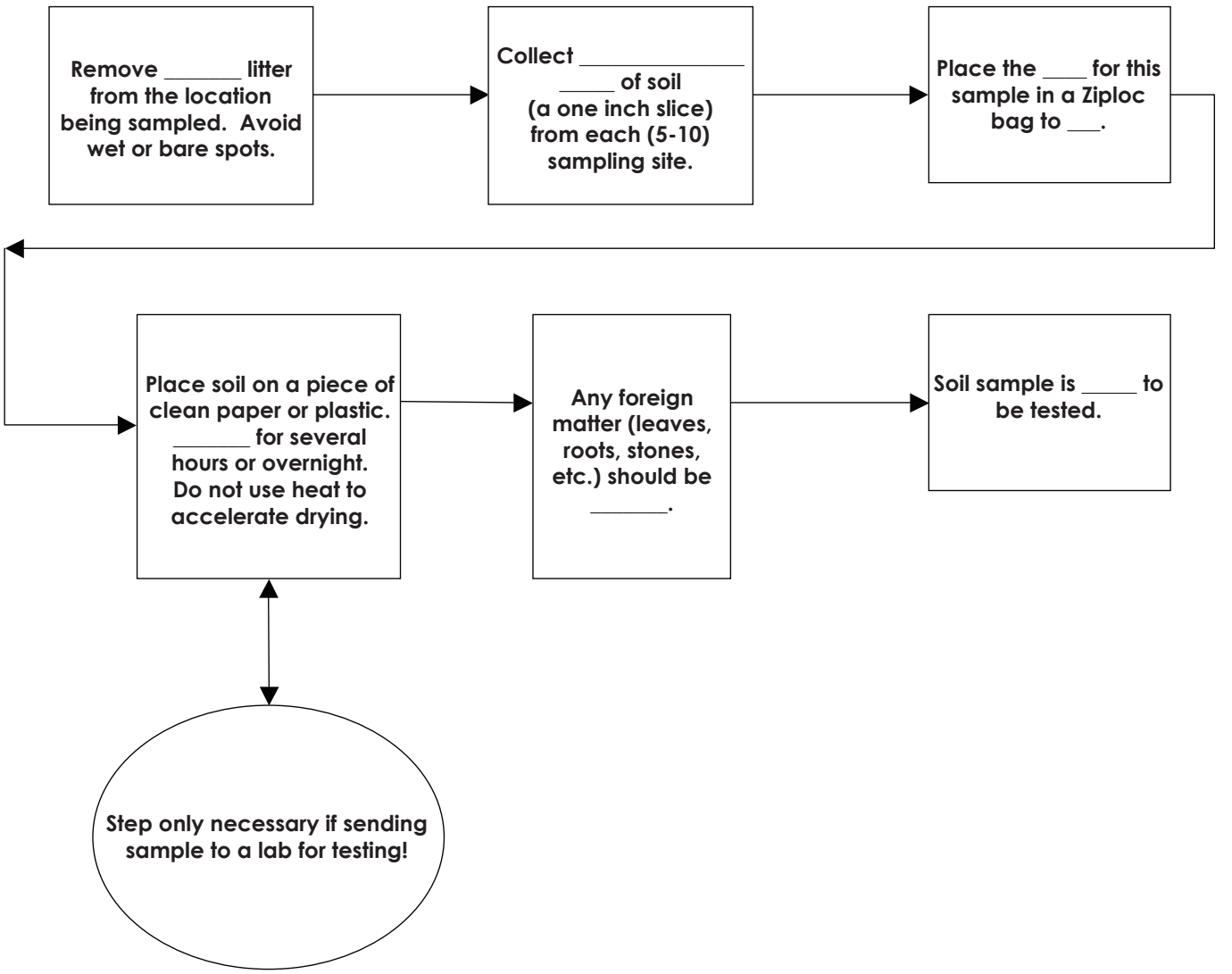


Tissue Test: nutrients in the plant itself, instead of nutrients in the soil, are tested. Can be used as a way to see if something is hindering nutrient uptake.

Soil Collection Flow Chart

Soil Test: _____

_____



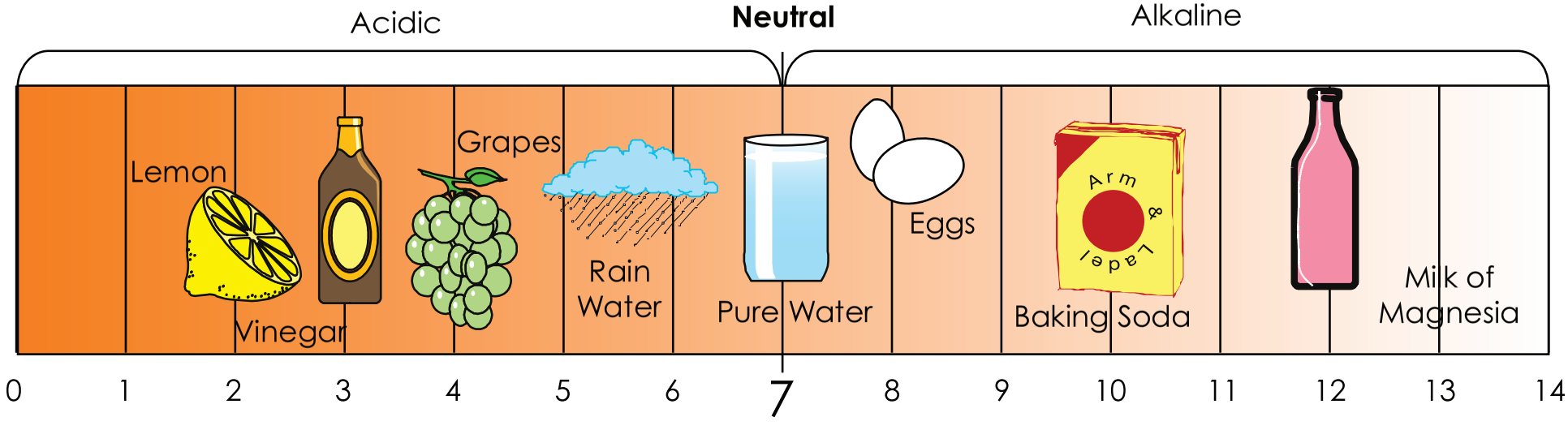
Tissue Test: _____

_____

_____

_____

pH Scale


Acidic
Neutral
Alkaline
Lemon
Vinegar
Grapes
Rain Water
Pure Water
Eggs
Arm & Hammer
Baking Soda
Milk of Magnesia
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14

To do the soil pH test:

Step 1 Put about 1 tablespoon of soil in a clean plastic cup.

Step 2. Add distilled water and stir until the sample is as thick as a milkshake.

Step 3. Let it stand for one minute. Check it and add water if needed.

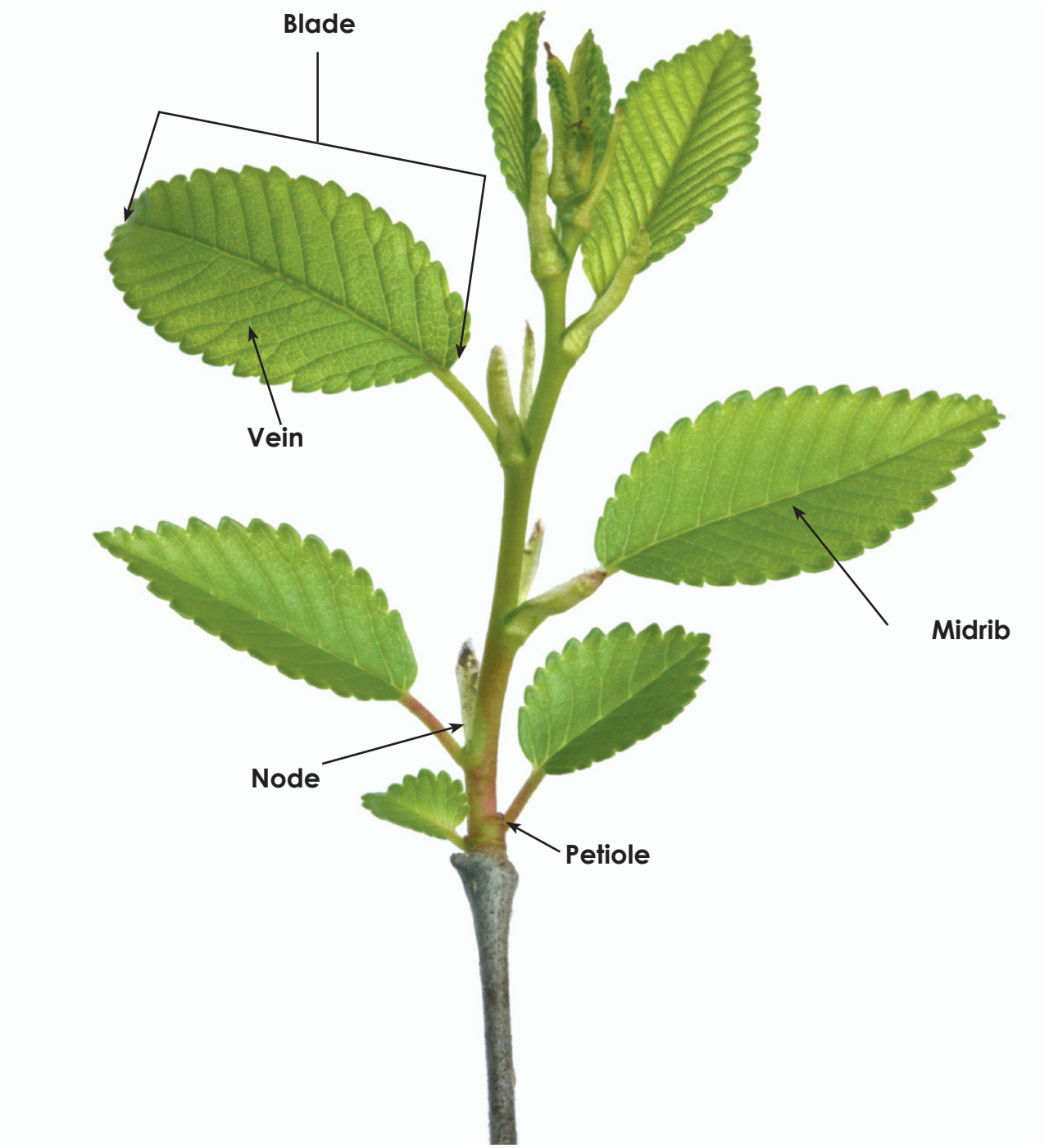
Step 4. Put a piece of test paper in the solution. Leave it in for one minute.

Step 5. Take the test paper out and rinse it with distilled water.

Step 6. Match the color of the test paper to the standard color chart that came with the test paper.

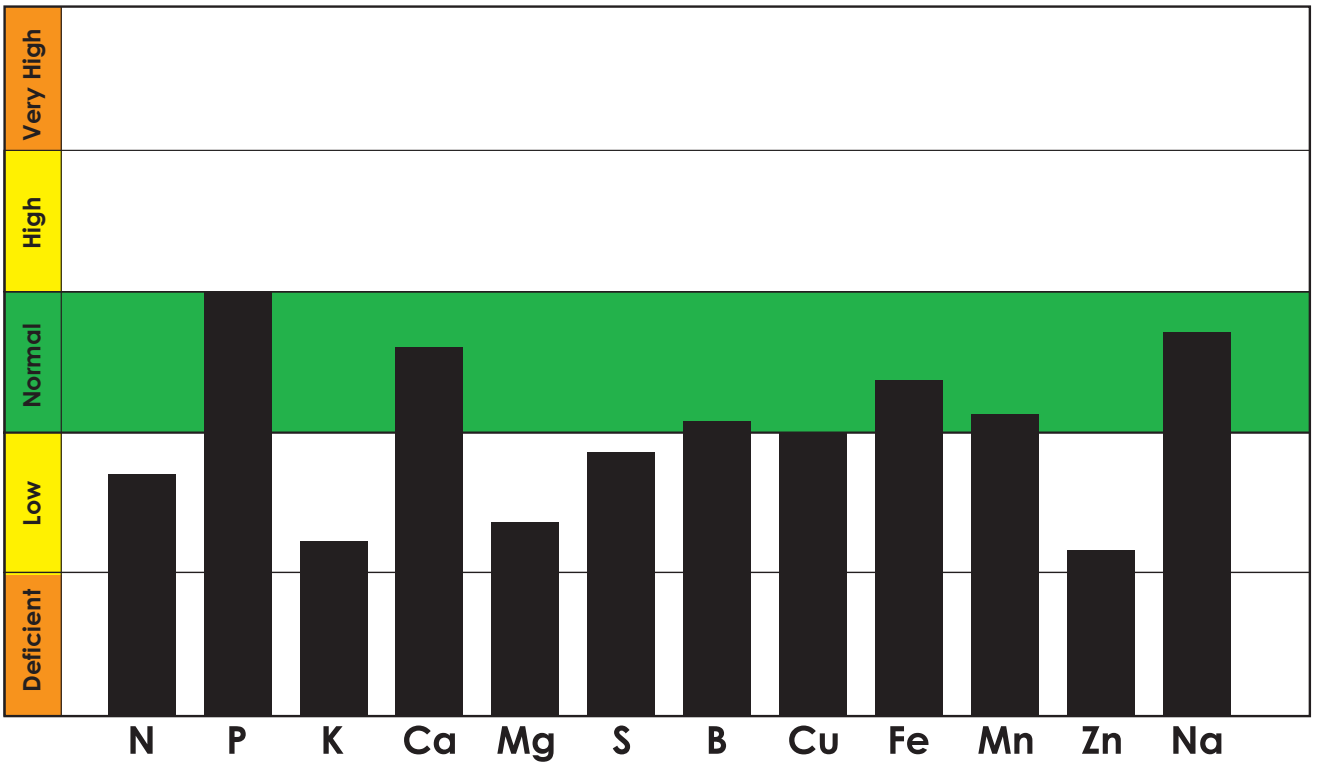
Step 7. Keep a record of your test results.

Parts of a Leaf



http://www.spectrumanalytic.com/services/analysis/samples/plant.pdf

Plant Tissue Nutrient Levels



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